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CODE OF PRACTICE FOR USE OF CURRENT METER (CUP TYPE) FOR WATER FLOW MEASUREMENTS

(Third Reprint MARCH 1998)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 4 March 1967

Indian Standard

CODE OF PRACTICE FOR USE OF CURRENT METER (CUP TYPE) FOR WATER FLOW MEASUREMENTS

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AMENDMENT NO. 1 JULY 1983

TO

IS:3918-1966 CODE OF PRACTICE FOR USE OF CURRENT METER (CUP TYPE) FOR WATER FLOW MEASUREMENTS

Alteration

(Page 5, clause 5.2) - Substitute the following for the existing clause:

'5.2 For measurements made by the one point method, the current meter should be exposed for 120 seconds or for 150 revolutions whichever occurs later. If measurements are made at more than one point in each vertical, the current meter should be exposed for a period of atleast 30 seconds at each point in the vertical. If the water velocity is known to be subject to periodic pulsations, it is advisable that the current meter should be exposed at each selected point for atleast two (preferably three consecutive periods) consecutive periods of 60 seconds or for periods of sufficient duration to cover atleast two periods of pulsation and the average of all the separate readings is taken as the velocity at the point. The velocity at the point should then be taken to be the average of all the separate readings, unless it is apparent that the difference is due to some cause other than pulsation of the flow. The readings may be stopped either at the end of a fixed time or the time should be observed for a fixed number of revolutions.'

(BDC 17)

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Indian Standard

CODE OF PRACTICE FOR USE OF CURRENT METER (CUP TYPE) FOR WATER FLOW MEASUREMENTS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 12 December 1966, after the draft finalized by the Fluid Flow Measurement Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Current meters play a very important role in stream gauging. Like other precision instruments, current meters, if properly maintained and handled give accurate results.

0.2.1 Indian Standard Specification for current meters (cup type) for water flow measurement (IS : 3910-1966*) lays down the functional requirements and acceptance tests for the standard size. This standard covers several factors which govern the accuracy of the instrument and methods for compensating possible errors.

0.3 The Sectional Committee responsible for the preparation of this standard has taken into consideration the practices followed in the country in this field. Furthermore, due weightage has also been given to the need for international co-ordination among standards prevailing in different countries of the world. These considerations led the Sectional Committee to derive assistance from Draft ISO Recommendation No. 948 ' Liquid flow measurement in open channels by velocity area methods '.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies the methods for use of current meters (cup type), sources of error in them, and their maintenance. Current meters of other types (for example, the propeller or horizontal axis type, and the inferential type) are not covered in this standard.

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*Under print.

†Rules for rounding off numerical values (*revised*).

2. GENERAL DESCRIPTION

2.1 The cup type (with the axis of rotation normal to the flow) current meter comprises the bucket wheel and spindle bearings, the contact box housing the contact breaker, the yoke or main frame, and the tail fin, the details of which are covered under IS : 3910-1966*.

3. ASSEMBLY AND ADJUSTMENT OF THE CURRENT METER

3.1 The current meter assembly shall comprise the tail unit consisting of four fins which shall be secured to the rear of the cradle casting by a taper pin. The lower of the tail fins carrying an adjustable counterweight shall be set so that the meter stands horizontally when suspended in water. The bucket wheel shall be clamped to the vertical spindle by a hexagonal nut. The pivot holder should be examined to ensure that the pivot point is not damaged. The cap of the contact box should be removed and the upper spindle bearing cleaned with a finely pointed piece of stick wrapped in clean rag. The bucket wheel assembled with the spindle shall be then placed in proper position, the pivot holder should be then passed through the lower boss ensuring that the raising handle (or device) is in raised position and the lower portion of the spindle shall be secured to it with the help of the clamping screw. The pivot holder itself shall be clamped securely to the cradle with the help of clamping screw. The contact box shall be placed through the upper boss and secured to the upper portion of the spindle in the cradle through the clamping screw. Before tightening the contact box to the cradle, it should be ensured that the pin in the upper portion of the spindle is deflecting the contact spring at every rotation.

3.1.1 After the current meter is assembled as above, it shall be subjected to various tests enumerated in **10.**

4. GENERAL ACCESSORIES REQUIRED

4.1 Stop Watch — A good stop watch shall be provided at each site. It should run for 30 minutes. It should be capable of being started, stopped and re-set to zero by consecutively pressing the head of the watch. It should work only when required and show the time correct to 1/5th of a second.

4.2 Batteries — Any dry battery which can give an EMF of 1 V can be used. It is desirable to have spare batteries always ready. The life of

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*Specification for current meters (cup type) for water flow measurement (*under print*).

a battery can be prolonged considerably by connecting the two terminals only when they are required, that is, at the time of counting revolutions and disengaging it at all other times.

4.3 Metallic Tape and Steel Tape — A 25 m metallic tape as well as a 25 m steel tape shall be provided at each of the sites.

4.4 Hand Winch — For lowering the meter and the log line it will be useful to have a hand winch with a good brake. It may be about 0·3 m in dia and 1 m in length with double purchase system (cog wheels to gain mechanical advantage).

4.5 Miscellaneous Articles — Ropes, screw drivers, cutting pliers, wrench, lubricating oil can, tag line points, coloured flags, ranging rods, painting brushes and enamel paints are the miscellaneous accessories which are useful at the discharge sites. A rope is useful in case of accidents. It should be sufficiently strong to pull a person.

4.5.1 Ready mixed paints with brushes should be always at hand to touch up the marks on the sounding and rigid rods which get obliterated by water.

5. VELOCITY MEASUREMENT

5.1 The velocity of liquid flow shall be measured by immersing the current meter in the manner described in this standard and determining the rate of revolution of the rotating bucket wheel. The velocity shall be deduced by reference to a standard calibration table or a graph or an equation giving correlation between rate of revolution and velocity of flow.

5.2 The current meter should be exposed at each selected point for a minimum of 40 s, and velocity should be deduced from an average of 3 readings. If the water velocity is known to be subject to periodic pulsations, it is advisable that the current meter should be exposed at each selected point for at least three consecutive periods of 1 min, or for periods of sufficient duration to cover, at least two periods of the pulsation. The velocity at the point should then be taken to be the average of all the separate readings, unless it is apparent that the difference is due to some cause other than pulsation of the flow. The readings may be stopped either at the end of exactly 40 or 60 s (as the case may be) or the time be observed for 50 or 75 revolutions respectively.

6. CURRENT METER SUSPENSION AND WEIGHTS

6.1 The velocity measurements should be made by immersing the current meter from a cableway and trolley, or motor launches or boats or bridges or by wading through (*see also* **6.7**, **6.7.1** and **6.7.2**).

6.2 Different types of suspension, such as rod suspension, hand line or logline suspension, rack and pinion suspension, etc, may be adopted depending on the depths and velocities required to be measured and also on the method of discharge observations such as from a cable car, from a bridge, from a boat, wading observation.

6.3 The best arrangement for holding a current meter in the desired position from a boat or a power vessel for measurement of velocity in rivers with depth up to 10 m is rack and pinion.

6.4 An important factor influencing the drag is the diameter of the suspension cable. A 10 mm diameter cable is convenient for use by hand, but it has a high resistance at high velocities and great depths. For depths exceeding 10 m or high velocity measurement, a 3 mm diameter cable used with a gauging reel, is the best means of suspension, if available.

6.5 Wading rods may be used wherever the stream is shallow and the velocity not excessively high, from a low footbridge or a boat, or by an operator wading in the river itself. In the latter case, it is important that the operator should not obstruct the flow of the stream to the instrument, thus causing a false velocity measurement. It has been found that the best position for him to occupy is that facing the nearer bank, with the meter about 0·5 m in front of him and slightly upstream. In such a position obstruction is negligible.

6.5.1 Wading rods are supplied in 1 m sections which screw together and are marked at 16·7 cm intervals with single rings. A circular base plate screws on to the bottom section.

6.5.2 The wire lead from the instrument to the revolution counter should be secured to the rod by clips.

6.6 Weights shall be added to the log lines or cables during current meter observations to keep the cable reasonably vertical. The higher the velocity and water depth, the greater the drag caused by the instrument and cable. The following sizes of weights are recommended:

10, 15, 25, 35, and 50 kg.

6.7 Wherever possible, efforts should be made to avoid measurements by the area-velocity method from a bridge, particularly high-bridges, as such measurements are generally over-measured with large errors. The bridge may not be normal to the flow, it may provide considerable obstruction or areas of slack and return flow; it may cause non-uniform and turbulent flow which affect correct measurements. A larger number of segments and verticals are necessary on account of more rapid changes in depths and velocities caused by the piers, while the measurements of the horizontal and vertical angles of the suspension cable for the essential wet line and air line corrections may be difficult to make due to bridge members and, in any case, it will not be possible to fully account for the error due to drag and abnormality of the current to the section line.

6.7.1 Where, however, measurements by a boat or cableway are not possible and measurements must be made from a bridge, the following conditions should be observed in selecting a bridge where there is a choice. A suspension bridge or a bridge with fewer piers and spans is to be preferred to a bridge with a greater number of pier obstructions. The piers should be long and slender and streamlined and aligned in the line of flow. The bridge should not be on a curved reach and the approach and exit should be straight. It should confine the whole river flow through the bridge spans. A bridge with less obstructive members facilitating the suspension of the meter without damage and a masonry or RCC structure subject to less wind and traffic vibrations is to be preferred.

6.7.2 In case of a bridge, measurements are more conveniently made on the downstream side-from the downstream parapet—provided care is taken to avoid drift materials (which is more difficult to observe) from damaging the current meter. More segments (which may be marked on the bridge members) will be necessary in the vicinity of the piers. Sufficient weights are necessary to minimize the drift and reel mounted cranes may be preferable to a hand line. While lowering or raising the current meter special care is required to avoid its damage. The safety of the current meter as well as the turbulence and eddies and separation of the current caused by the easewater prevent measurements close to the piers, and so suitable segmentation, close and yet safely removed from the piers, would enable estimation by extrapolation of the velocity and depth curves to the pier faces. Air line and wet-line corrections shall be made for the deflection from the true vertical despite the weight attached for the measurement of depth.

6.7.3 With all the precautions and corrections, discharges from a bridge are largely overmeasured and data exists of comparisons by boat measurements to show that the error may exceed 20 percent.

7. FACTORS AFFECTING THE ACCURACY OF THE CURRENT METER AND THE METHODS TO COMPENSATE ERRORS

7.0 Correct sounding technique and the use of current meters offers the best known method of stream gauging. However, in actual practice, there are various factors which affect the accuracy and at best, under ideal conditions of a lined uniform section with constant discharge and water level, the minimum error under field conditions cannot be expected to be less than ±2 percent. The principal factors that affect the accuracy are described in **7.1** to **7.7**.

7.1 State of Flow — Current meters are rated in a rating tank where turbulence, eddies, swirls and similar disturbances, are absent. It is, therefore, advisable to avoid observations where excessive turbulence occurs and where cross currents, swirls, eddies and similar disturbances and agitation of water are met with.

7.2 Angle of Current — A measuring cross-section of a stream shall be so chosen that the flow is reasonably normal to the section. Deviation from the true normal may, however, occur at some observation points especially in wide and turbulent streams. To obtain accurate discharge measurement, this inclination shall be taken into consideration and the velocity component normal to the section computed and used in discharge calculations. Horizontal angle may be measured by means of sextant, using a wooden float attached to a cotton cord when velocities are being observed at the surface. When cable suspension is used, care shall be taken to ensure that there is no tortional effect which would prevent current meter to direct itself along the flow direction.

NOTE — Other convenient instruments that have been recently brought out are ' pendulum current meter ' devised at Delft laboratory and the ' direct reading current meter ' brought out by Kelvin Hughes.

7.3 Effect of Wind — The wind may affect current meter observation in several ways. If observations are made from a cable car or from a suspension bridge, the wind may cause these structures to oscillate, causing the current meter to swing inside water. If a boat is used, it may heave due to waves. Besides disturbance so caused, the wind action may cause considerable variation in the surface velocities both in respect of magnitude and direction. If velocities are to be measured at the surface or at 0·2 depth, it is preferable to avoid heavy wind when it is in or against the direction of flow. At all important sites it is desirable to use an anemometer and record the velocity of wind during the observations.

7.4 Drift, Aquatic Growth — When velocities are measured during floods, care should be exercised to ensure that drift materials such as tree branches do not disturb or damage the current meter and its suspension. Aquatic growth on the channel bottom is also likely to interfere with the operation of the current meter observation specially when velocities are measured near the bed or at 0·8 depth.

7.4.1 *Measurement of Discharges in Weed-infested Channels* — Wherever possible, effort should be made to avoid a weed-infested reach and locate the measuring station elsewhere. Where it is impossible to find any weed-free site suitable in other respects the method in **7.4.1.1** is likely to yield the best approximation of the flow, but not without a larger error than may normally be expected from measurements at a clear site.

7.4.1.1 As weeds grow continuously, there is progressively increasing reduction in the effective sectional area and in the velocity and the point of mean velocity along a vertical is also continuously changing. In weed-infested sites, therefore, the point of mean velocity should invariably be determined for each segment of flow during each measurement. Moreover, the number of segments (or verticals) should be relatively larger than in weed-free channels of the same dimensions and discharge. As far as possible, the width of the segment should be fixed on the basis of significant uniformity of weed growth in a segment and the area of the segment scaled down by an appropriate factor based on judgment and experience, for example, the area of the segment may be taken as 0·9 to 0·95 times the free area where the weed growth is light, but only 0·75 to 0·8 times the free area where the weed growth is moderately thick, and so on. In other respect, the normal single-point or surface velocity area method may be used until further research.

NOTE — It is recommended that in channels where there are weed-infested as well as clear reaches, research should be carried out by comparative measurements, particularly on the point of mean velocity and the reduction factors to be applied to obtain the area of waterway.

7.5 Effect of Water Temperature — Temperature is also supposed to have some effect on reading of the current meter. It may however, be considered negligible for the range of velocities usually measured and for the range of temperature usually met with.

7.6 Effect of Proximity of Boundary — It is generally presumed that the current meter rating is affected due to proximity of the boundary, bed and banks of the channel and the free surface.

NOTE — According to the experiments done in Central Water & Power Research Station, Poona, if the velocities are observed at 0·3 m from sides as well as bottom, the current meter observations will be subject to negligible boundary effect (less than ± 0·6 percent). Similarly, experiments have indicated that the cup type meter under registers when held within 0·15 m of water surface, the error increasing progressively towards the surface. Observations of velocities within 0·3 m below surface of water may be avoided. This is applicable to smooth flumes. In the field a distance of 1 m from the boundary is desirable.

7.7 Observation at Low Velocity — A cup type current meter suspended from a bobbing boat may be seriously in error if the velocity is of the order of 0·3 m/s or less. The cup type current meter should not be used under these circumstances.

8. TESTS FOR A CURRENT METER BEFORE USE

8.0 The following tests shall be carried out before and after the day's observation.

a) Spin test,
b) Slow motion test, and
c) Response to velocity change test.

8.1 Spin Test — The meter shall be rested on a horizontal flat surface such as a table top and a hard spin shall be given to the bucket wheel by hand. Without spring contact, the spinning time shall be a minimum of 90 s and with spring contact the time shall be a minimum of 75 s.

8.2 Response to Velocity Change Test — Immerse the current meter at 0·6 d and lower it to 0·8 d; the change in number of revolutions of the bucket-wheel shall be significant in a period of 30 s, even for small changes of velocity of 0·3 m/s between the two depths. The mean velocities to be gauged for the purpose of this test shall be not more than 3 m/s or less than 0·5 m/s.

9. OPERATION AND CARE OF CURRENT METERS

9.0 Like any other precision instrument, the successful operation of a current meter will largely depend on the care with which it is used. Although the design, material and construction of the meter are major factors contributing to its successful operation, they will not prevent inaccuracies caused by improper handling of the instrument. Therefore, every effort has to be made to keep the meter in good condition and there should be no replacements that are likely to affect the rating of the instrument. For satisfaction regarding the condition of the meter, it should be examined both before and after each measurement as per the tests prescribed in **8**.

9.1 A current meter records actual velocities with faithfulness within the range of its rating only, provided it is carefully handled and properly maintained. Special care shall be taken to see that no damage is caused to the moving parts of the meter, such as cups, shaft of the wheel and the pivot bearings. These parts are likely to get bent, pitted or disfigured, if they received sharp blows or if they are tried to be taken out or thrust in forcibly while assembling or dismantling the current meter. Proper care shall be exercised on the following requirements:

a) *Cable Suspension* — With cable suspension, the cables should not have an initial torsion and it should be sufficiently weighted so that it remains stable in the current and does not oscillate or swing.

b) *Balancing* — Accurate balancing of the meter should be tested under water after the weight is attached. This may be done by the balancing weight meant for the purpose, which is attached to the fin of the meter.

c) *Electric Cable* — It shall be ensured that the electric cable leading from the contact chamber does not interfere with the free movement of the cup wheel.

d) *Pivot* — The pivot should be periodically examined with a magnifying lens to make sure that the point is not damaged. Before replacing the current meter in the box, the pivot bearings should be raised off the point of the pivot. If the pivot gets coated, a blunt soft wooden pin covered over with a soft cloth may be used for cleaning.

e) *Spin* — Besides the duration of spin, as specified in **8**, a meter in proper working order should come to stop gradually. A sudden stop indicates a defect and points to the need for a check.

f) *Working* — The working of the meter may be improved by cleaning and oiling; and if necessary new spare pivot may be substituted. After the observations are completed the instrument should be dried, water expelled from the contact box, and the pivot bearing surfaces shall be thoroughly cleaned and oiled. If a new spare pivot is substituted for improving the working of the meter, the meter has to be re-rated.

9.1.1 Proper handling and rigorously following the instructions given by the manufacturers are important. If the meter performance is not satisfactory even after these, the meter shall be reconditioned by a competent instrument mechanic and properly re-rated before putting into further use.

9.2 Observation with a Defective Meter — If for any reason, observations have to be made with a defective meter (that is a meter in which doubts exist regarding the applicability of the rating or calibration table), an ' as is ' rating (one made of the meter in the exact condition as used in the field) shall be obtained at the earliest opportunity there-after. If the ' as is ' rating is not obtained before further changes are made to the meter, it is not possible to detect any error that may be caused by use of the previous rating.

9.3 Dismantling for Examination and Cleaning Pivots and Bearings — The principal parts of the instrument have been elucidated in IS : 3910 - 1966*.

9.3.1 To dismantle the intrument, loosen the clamping screws which secure the pivot and remove it from the (cradle) yoke casting.

9.3.2 Turn the bucket raising lever (or device) to the 'lowered position' (pointing towards tail vane), and withdraw the bucket and spindle. Clean the cup by using a pointed stick wrapped in clean rag.

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*Specification for current meters (cup type) for water flow measurement (*under print*).

Make sure that upper spindle is clean, and after placing a drop of thin oil in the cup, replace the spindle and the bucket in cradle.

9.3.3 Clean the pivot and examine it with a magnifying lens to make sure that the point is not damaged. Re-insert after getting the raising lever to the " raised position " and clamp securely.

9.3.4 Remove the cap of the contact box and clean the upper spindle bearing (or pivot) with a finely pointed piece of wood. Replace the contact box in the yoke, turn the terminal to the rear and tighten the clamping screw so that it engages with the dimple drilled in the spigot of the contact box.

9.4 The meter shall be put to spin test before and after taking measurements.

9.5 The fish weights should be ensured to play freely and take the direction of the current.

9.6 If any apparent inconsistency on the results of an observation without there being any change in the conditions of the river (for example, velocity at 0·2 d being less than at 0·8 d, at any observation point in the middle of the stream being less than that of an observation point near the banks, etc) throws doubt on its accuracy, the cause should be investigated at once. It may be due to one or more reasons. Grass may get wound around the cup shaft; the contact point may require adjustment so as to make contact with the dimple drilled in the spigot of the contact box for every revolution; the insulated cable connection may have become loose; the chain may be obstructed immediately above the meter, the meter may be in a hole or touch rocky out-crops; or the cups may be bent so as to come in contact with the cradle (yoke).

9.7 The meter does not give reliable measurements below the lowest velocity for which it is rated, and measurements below this limit should be avoided. For velocities below 0·3 m/s it is necessary to make the routine spin test regularly and to check the calibration more frequently.

9.8 In very small streams the meter should be suspended from the lower hole in the suspender rod and the weight should be placed above; as otherwise, it would not be possible to lower the meter to 0·6 or 0·8 d.

9.9 If the cups of the meter are bent, they may easily be put into shape by using a wood or metal bar with a round smooth end.

9.10 The headphone receiver is very sensitive to electric currents and can be used to locate any break in the circuit. The headphone and the battery together in a circuit should be tried first by having a make and break point. This may be done by using a knife, blade or a screw driver making connections where the wire enters the plug. If there is no click in the headphone, then the battery or the headphone does not make a circuit. If there is a click, the meter is inserted in the line and tested for contact in the meter head by revolving the meter wheel.

9.11 When the meter is not in use, as during movement from observation point to observation point, the meter line should be disconnected from the battery so that the latter may not get discharged. A connection plug should be inserted in the line to break and make the circuit easily. Also when not in use the poles of the battery should be covered up with insulating tape to avoid short circuiting.

9.12 The headphone receiver should never be dropped or struck against other object lest the pole pieces should get demagnetized.

9.13 If a dry cell which has been long in stock fails to work well, two nail holes may be punched in the wax on the top of the cell and water put in overnight when it will absorb enough moisture to renew it. The holes should then be coated with wax.

9.14 All contact points and wires should be kept clean and bright.

10. FAULTS IN REVOLUTION COUNTING

10.1 When the meter is connected to the counter and the bucket wheel revolved, if the counter fails to operate, it may be due to any of the following causes:

a) Exhausted batteries,

b) Faulty connection to counter,

c) Broken electrical connection between instrument and counter,

d) Contact breaker failing to make or break circuit, or

e) Dirty contacts.

10.2 Test systematically as follows until the fault is located.

a) Switch on the counter and short circuit the two-pin plug at the end of the counter connecting lead. If the short circuit is interrupted the counter should operate. If it does not, the fault lies in the counter connecting lead or the counter itself.

b) Connect the counter to the suspension cable and the cable to the instrument. If the counter fails to operate when the bucket wheel is revolved, hold the two-pin plug at the end of the counter connecting lead against the contact box terminal and the frame of the instrument and again spin the bucket wheel. If the counter now operates there is a fault in the suspension cable or wading rod cables.

c) If the fault lies with the contact breaker in the instrument remove it by unscrewing the knurled ring and determine whether the platinum contacts are pressing together. They may require cleaning with petrol. A drop of thin oil on the contact will prevent short circuiting when gauging in salt water, which is highly conductive. Make sure that the earth contact at the end of the contact spring is sufficiently protruding to make a good connection to the tube of the contact box.

d) If adjustment (c) is satisfactory, and the counter still fails when the contact breaker is replaced, the pin on the bucket spindle may be deflecting the contact spring. Remove the contact breaker and adjust the bend in the contact spring so that, when replaced, the circuit is interrupted through 30°-60° of the rotation of the bucket wheel.

11. FIELD INSTRUCTIONS

11.1 A few instructions are necessary for the field operation of the instrument. They may be summarised as follows:

a) If a suspension cable is being used, take particular care to clamp the instrument to the suspender rod so that it is in line with the sinker weight, and make sure that suspender rod is securely connected to the cable adapter.

b) Attach the spade connectors from the suspension cable or the wading rod cable to the meter contact box and earth terminals. It is advisable to turn the spade connectors in line with the stream flow.

c) Ensure that the pivot clamp screw and the contact box clamp screw have been sufficiently tightened.

d) Before lowering the instrument into the water, the bucket wheel should be lowered on to the pivot and spun by hand to ensure that it will spin freely.

e) Connect the electric revolution counter or flash counter and ensure that it registers the revolutions precisely. If there is any doubt about the condition of the batteries, replace them by new ones if possible.

f) After the current meter is placed at a selected depth in the vertical, the depth being measured to the centre of the bucket wheel, the current meter shall be permitted to adjust to the current for a period of half a minute before the reading of the instrument is started.

For low velocities of 0·3 m/s or less, this time shall be not less than 2 min.

After the current meter has adjusted itself the length of time taken for each reading shall be not less than 40 s making sure that readings are stopped after the completion of a full revolution after 40 s or 50 revolutions, whichever is earlier, in order to eliminate the pulsating effect of the current.

g) When observations have been completed for the day, the instrument should be dried to expel water out of the contact box. The pivot shall be dried and oiled before replacing.

h) The bucket wheel shall always be raised from the pivot before replacing the instrument in the case.

12. CALIBRATION

12.1 The current meters used for measurement of flow shall be sent to a properly equipped rating tank, after 300 working hours or after a total period of six months, whichever is earlier, for periodical calibration and check.

(*Continued from page* 2)

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